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Consultation Report

Biology 20–30
Chemistry 20–30
Physics 20–30

September 2004

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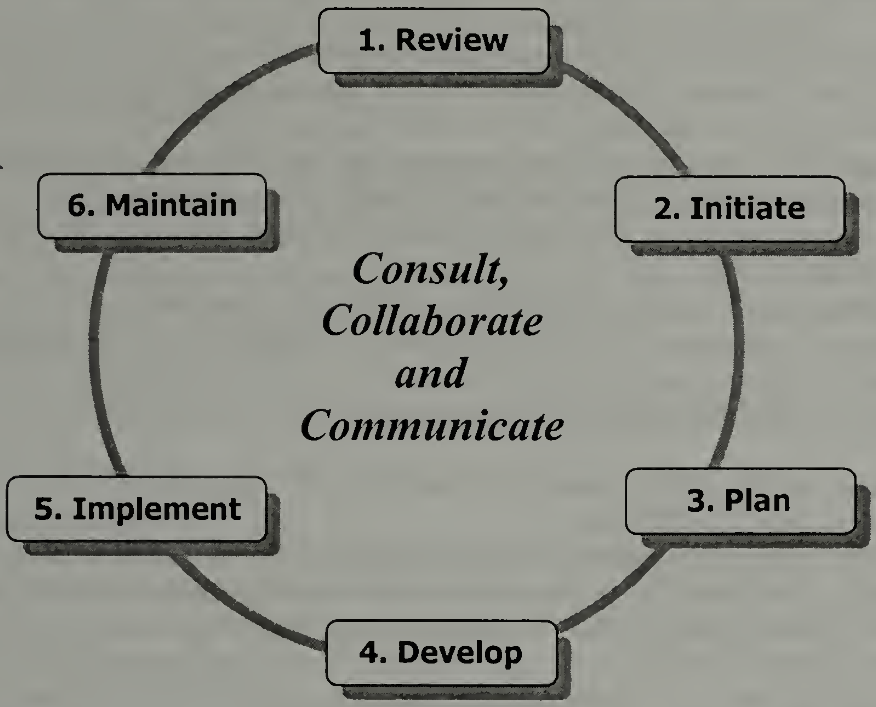
SECTION A: Executive Summary

Revising programs of study is a major undertaking involving many people. Consultation with clients, partners and stakeholders is an integral and important component of the curriculum development cycle. Programs are reviewed after a certain period of time to determine if a change is needed, and if so, what kinds of changes are required and how soon.

PROGRAMS OF STUDY AND THE SIX-STEP CURRICULUM DEVELOPMENT CYCLE



Background

This executive summary consists of a general summary of the major findings from two principal consultation processes:

- needs assessment (Section B of this report contains the detailed summary)
- responses to consultation drafts (Section C of this report contains the detailed summary).

This consultation report provides summaries of data, information and comments from several hundred individuals who responded through:

- science education leaders' symposia (1997 and 1998)
- the Secondary Science Program Review Questionnaire (1998)
- the ATA Science Council Conference Senior Secondary Science Survey (November 2000)
- round-table discussions and science regional meetings (2003)
- Alberta's Biology 20–30, Chemistry 20–30, Physics 20–30 Consultation Draft Program Outcomes Questionnaire (2003).

Needs Assessment

In 1997–1998, a needs assessment was initiated to gather feedback in determining the direction for changes to the secondary science program. Revisions began with the Science Grades 7–8–9 Program of Studies (implemented in 2003) and continued with the Science 14–24 Program of Studies (implemented in 2003) and the Science 10–20–30 Program of Studies (to be implemented between 2004 and 2007). The change cycle for Biology 20–30, Chemistry 20–30 and Physics 20–30 began in 2001 when an advisory committee was established to work under the direction of Alberta Learning staff to review the feedback received and revise the programs. The consultation drafts for these programs were completed in the spring of 2003.

From the needs assessment it was clear that respondents generally supported the Biology 20–30, Chemistry 20–30 and Physics 20–30 programs implemented in schools beginning in the 1993–1994 school year. Respondents to the Secondary Science Program Review Questionnaire (1998) recommended some revisions to these programs but suggested that these should not be extensive. They identified the following as major strengths of the programs:

- The programs meet the needs of students in terms of a foundation for further studies and for scientific literacy.
- There is appropriate emphasis on knowledge, skills and attitudes.
- The science, technology and society (STS) component of the programs supports scientific literacy.
- The amount of content is generally appropriate.

The general recommendations for changing the Biology 20–30, Chemistry 20–30 and Physics 20–30 programs included the following:

- Update the programs to reflect recent developments in the particular subject area, including research findings, technological advances and their implications for society.
- Review the background provided by Science Grades 7–8–9 and Science 10 for 20- and 30-level courses.
- Ensure that students are learning what is essential to help them make the transition to post-secondary studies.
- Better define the intended depth of treatment, and align with expectations on diploma examinations.
- Do not add additional content without removing something.
- Incorporate information and communication technology (ICT) outcomes, and facilitate learning using technology and computer literacy.
- Foster a love of learning and excitement about science—leading to a lifelong interest.
- Show students the connections of science to their lives and the array of career opportunities in the sciences.
- Emphasize problem solving and critical thinking.
- Facilitate hands-on learning and laboratory experiences.
- Better align the programs with those in other Canadian jurisdictions.
- Provide updated learning and teaching resources.

Specific program responses included the following:

- In Biology 20–30, fine-tuning should focus on the background provided by Science 10, placement of topics at each of the levels, indications of depth of treatment, less emphasis on detail of basic processes, and rounding out the human physiology component.
- In Chemistry 20–30, the comments suggested both narrowing and broadening the treatment of particular topics (e.g., organic chemistry, acids and bases), improving transition to post-secondary studies and increasing the emphasis on applications, problem solving and laboratory work.
- In Physics 20–30, it was recommended that the program better reflect modern physics, incorporating themes such as cosmology, providing more practical applications, and placing greater emphasis on the integration of physics and mathematics.

Responses to Consultation Drafts

The consultation drafts for Biology 20–30, Chemistry 20–30 and Physics 20–30 were placed on the Alberta Learning Web site with a response questionnaire in June 2003. The opportunity to respond to the consultation drafts was extended to January 2004. Additional opportunities to respond were provided through consultation forums at ATA Science Council conferences, and at workshops and discussion groups. Other input was received by e-mail and at meetings and working groups. All of this feedback was considered in making revisions to the consultation drafts. Resource development drafts, incorporating the changes, are posted on the Alberta Learning Web site at http://www.learning.gov.ab.ca/k_12/curriculum/bySubject/science/default.asp.

Online Questionnaire

There was a relatively small number of responses (30) to the online response questionnaire on the consultation drafts for Biology 20–30, Chemistry 20–30 and Physics 20–30. The majority of respondents (73%) were senior high school classroom teachers, with university or college faculty making up the next largest group of respondents (10%). Respondents' comments are summarized below.

Generally, the respondents were supportive of:

- the senior high school science program rationale and philosophy
- the four foundations—knowledge, skills, attitudes and STS—of the senior high school science program
- the details in the frameworks for science, technology and society (STS)
- the senior high school science program organization.

The responses to the program outcomes varied with the outcome set and were specific to each of the programs:

- Most respondents indicated that the general outcomes were clearly stated and appropriate for students, with some exceptions noted, mainly for Biology 20–30.
- Respondents found the specific outcomes for knowledge to be clear.
- Some respondents expressed concern that the specific knowledge outcomes for Biology 20–30 and Chemistry 20–30 lacked the level of specificity that indicates depth of treatment, or were placed at an inappropriate level.

- Specific outcomes for science, technology and society were generally rated as clear for Biology 20–30 and Chemistry 20–30, but less clear for Physics 20–30.
- The majority of respondents agreed that the outcomes for science, technology and society were appropriate for senior high school science students.
- Most respondents indicated that the skills were clearly explained and appropriate for students, with strong support related to Physics 20–30 and exceptions noted for Biology 20–30.
- The examples provided in the italicized sections of the consultation drafts were generally found to be appropriate, with some exceptions noted for all three programs.
- Most respondents supported the organization of Biology 20–30, half of the respondents expressed concern with the organization of Chemistry 20–30, and the organization of Physics 20–30 received mixed reviews.
- Most respondents for each subject agreed that the links to mathematics, information and communication technology and the STS frameworks are helpful.
- The majority of respondents considered the amount of material in Chemistry 20–30 to be appropriate, while a small majority of respondents considered the amount in Biology 20–30 to be too much. Less than half of respondents considered there to be too much material in Physics 20–30, and almost one quarter indicated more could be added.

The last part of the questionnaire invited respondents to provide additional comments. Refer to Section C of this report for a summary of these specific comments and responses to them.

Round-table Discussions

Most of the general comments from round-table discussions reinforced what was recorded in the questionnaire:

- Support was strong for incorporating science, technology and society (STS) connections.
- Some respondents would like to see a story line carried through each unit of study.
- Caution was advised about adding any more content to the programs which are challenging to cover already—if something is added, something else must be taken out.
- Ensuring articulation from lower level to higher level courses was a fairly high priority for many participants.
- Revised or new learning and teaching resources were recommended for all programs.
- How to incorporate information and communication technology (ICT) into learning should be considered in the revisions.
- Alignment of provincial assessments with program outcomes was seen as important.

Comments specific to each program are included in Section C of this report.

SECTION B: Description of Consultation Process, Background and Needs Assessment

Alberta Learning's consultation process on Biology 20–30, Chemistry 20–30 and Physics 20–30 began in 1997 after publication of the Pan-Canadian Science Framework. This work was initiated within the context of reviewing all junior and senior high science programs after the introduction of the revised K–6 Science program in 1996. The focus was to ensure articulation from Kindergarten to Grade 12, to address any concerns from the field and to update content and resources. Consultations included focus group forums, survey questionnaires and round-table discussions with interested individuals and groups. Several hundred responses were received and summarized. Advisory committees considered all of these sources of input in their deliberations as they met to provide direction to Alberta Learning for revising the programs.

Consultation Process

1. Clients, Partners and Stakeholders
   Consultation forums and surveys took place between 1997 and 2003 to gather feedback from a variety of clients, partners and stakeholders, including:
   - teachers, administrators and district curriculum consultants
   - organizations; e.g., the Alberta Teachers' Association (ATA) and the Alberta School Boards Association (ASBA)
   - post-secondary educators from the major institutions in Alberta
   - business and industry
   - professional organizations, government and non-government agencies
2. Round-table Discussions
   - science education leaders' symposia (1997–1998)
   - ATA Science Council conference and science regional meetings (2003)
3. Surveys and Questionnaires
   Two questionnaires with specific questions on the discipline sciences were posted electronically and distributed at consultation forums by Alberta Learning:
   - Secondary Science Program Review Questionnaire (1998)
   - Alberta's Biology 20–30, Chemistry 20–30, Physics 20–30 Consultation Draft Program Outcomes Questionnaire (June 2003)

   A survey was also conducted by the ATA Science Council at Conference 2000.
4. Advisory Committees
   - Science K–12 Advisory Committee
   - Science 10–12 Advisory Committee
5. Field Validation
   Field testing of the revised programs will take place in the years prior to implementation to gather additional feedback on the outcomes and the draft learning and teaching resources selected for development.

Needs Assessment

After the publication of the Pan-Canadian Science Framework, a needs assessment was initiated to determine the direction for changes to the secondary science program in Alberta. Information was gathered in round-table discussions and through questionnaires. A summary of responses and emergent themes follows.

Highlights from Round-table Discussions at Science Education Leaders' Symposia (1997–1998)

A broad range of science education stakeholders, including teachers, administrators, post-secondary, business and industry representatives and students, attended two science symposiums held in December 1997 and March 1998. These forums provided participants with an opportunity to tell Alberta Learning what was working in science education and what could be improved. The themes relevant to the senior high school discipline sciences that emerged from the round-table discussions included the following:

Strengths of the Current Programs

- emphasis on meeting science literacy of students
- STS component
- focus on practical applications and real-life technical and social issues
- provide students with opportunities to "see science in action and do science through activities"
- social issues, ethics in biology program

Depth and Scope of the Programs

- intended depth could be better defined
- balance content focus on knowledge with time for skill development/focus on big ideas
- review number of topics in Physics 20
- broaden scope of Chemistry 30 to four units
- rigour is appropriate
- don't sacrifice depth for scope
- stress the basics

Areas Needing Improvement

- critical thinking and open-ended problem-solving abilities
- articulation from junior high to Science 10, from Science 10 to the disciplines, and from the disciplines to post-secondary
- links to the community, developing partnerships
- encourage creativity
- fun side of science—love of learning
- mathematical skills to do the science
- integration across the disciplines

Suggested Additions

- more earth and space science and botany
- access to learning using technology; computer literacy
- career opportunities
- teamwork and communication skills of students

Highlights from the Secondary Science Program Review Questionnaire (1998)

In 1998, a questionnaire was posted on the Alberta Learning Web site and distributed at several forums and conference presentations. This questionnaire included a component designed to elicit direction for revising Biology 20–30, Chemistry 20–30 and Physics 20–30.

Comments Specific to Biology 20–30 (45 responses received)

- Over 80% of respondents indicated that the 1998 program of studies was meeting the needs of students fairly well to very well. Representative comments have been paraphrased below:
  - provides a good foundation
  - Science 7–9 could provide a better background so students are better prepared for senior high school studies
  - would like to see a broader variety of topics—less human biology oriented approach
  - allow more time for hands-on, interesting laboratory work
  - incorporate the "high tech new stuff," learning with computers
  - the study of human systems serves our students who are going on to medical fields very well, and is relevant to students' lives
  - include taxonomy, microbiology and botany, as students would be better served with more background in these topics
  - there is lot to cover—don't add more, especially to Biology 20
  - add more on STS (e.g., mitigation, environmental impact studies, sustainable development, reclamation) in the ecosystems unit
  - more on nutrition, health, HIV in human systems
  - genetics—add references to hormone-mimicking synthetic compounds, gene banks to preserve genetic diversity
  - the chaos theory needs less emphasis—there is little support in the text
  - reduce the spiralling and keep the abstract topics such as osmosis, diffusion and active transport for the 20 level
  - the environment and food webs is mostly covered in lower grades
  - include a comparative study of life forms in the biosphere
  - the details of photosynthesis and respiration could be de-emphasized at the Biology 20 level
  - less emphasis on content knowledge and more on analysis and synthesis
  - would like to see more on evolution at the 30 level
  - retain the mandatory field studies
  - skill development requires excellent facilities and equipment
  - use more integrating concepts; e.g., homeostasis
- Over half of respondents found the learner outcomes to be stated clearly and in appropriate detail. Representative comments have been paraphrased below:
  - easy to follow and plan from
  - clearly laid out and easy to understand
  - language could be more concise
  - layout is fine, but difficult to read
  - unity of themes tends to get lost
  - well organized

  - not enough detail to provide direction for diploma exam questions—need to go to the Diploma Examination Bulletin and learn from experience
- Almost 65% of respondents indicated that the learning resources supported the program of studies fairly well or well. Sixteen percent suggested a major resource change was needed. Representative comments have been paraphrased below:
  - like that the text follows the curriculum closely
  - appropriate reading level
  - both basic textbooks need supplementing and updating
  - not enough quality resources to support the program in French
  - need more support for STS component
  - ACCESS videos and Classroom Assessment Materials Project (CAMP) are very helpful
  - test banks need supplementing
  - need additional support for ESL students
- When asked how extensively the program should be revised, 60% of respondents recommended changes. Representative comments have been paraphrased below:
  - update to keep up with today's technological developments
  - don't make major changes as the program is working well
  - restrict to fine-tuning and updates
  - too great a leap from Science 9 to senior high
  - align science programs across Canada to help students who move, to prepare for post-secondary
  - increase the skill component
  - reduce duplication between Biology 20 and 30

Comments Specific to Chemistry 20–30 (29 responses received)

- Over 85% of respondents indicated that the 1998 program of studies was meeting the needs of students fairly well to very well. Representative comments have been paraphrased below:
  - good preparation for post-secondary
  - students could be better prepared for post-secondary advanced courses
  - Science 7–9 needs to provide a better background for senior high school
  - more time is needed—difficult to cover all the content, including STS
  - too much emphasis on detail at the expense of the big picture and the applications of chemistry
  - students tend to solve problems mechanically, without a lot of thinking
  - would like more time to do laboratory work
  - Chemistry 20 is heavy and Chemistry 30 may be a little too light
  - incorporate the high tech new stuff, learning with computers
  - program needs more emphasis on problem solving and application of theories
  - not enough emphasis on organic chemistry, which is required for nursing, pharmacy, medicine etc.
  - would like to see radioactivity emphasized so students understand isotopes in research
  - delimit content in acid-base unit of Chemistry 30

- Over half of respondents found the learner outcomes to be stated clearly and in appropriate detail. Representative comments have been paraphrased below:
  - use models of course organization which focus on interrelated themes
  - knowledge could be better scaffolded so learning is more efficient
  - like the unit organization
  - too wordy
  - some are detailed, some are too general
  - more detail would be helpful, so less interpretation required
  - okay to let teachers make decisions about depth of treatment, but this leads to diploma exam writers interpreting for everyone
- About 55% indicated that the learning resources supported the program of studies fairly well or well. Twenty percent suggested a major resource change was needed. Representative comments have been paraphrased below:
  - chemistry textbook is good—follows program of studies at appropriate reading level
  - basic resource is excellent with supplementation—BC edition is better
  - need better resources for programs delivered in French
  - like the workbook supplements
  - organization and sequencing of basic text is poor
  - not enough specifics on STS
  - learning resources need to be updated more frequently
  - science is changing very fast and the resources need to keep up
- When asked how extensively the program should be revised, 66% of respondents recommended minor to major changes. Representative comments have been paraphrased below:
  - revise to better prepare for post-secondary transition
  - revise the junior high program—it provides weak background
  - high school curricula are sound—in need of updating and fine-tuning
  - revise slightly to keep up with today's technologies
  - align science programs across Canada to help students who move, to prepare for post-secondary
  - increase the skill component
  - reduce history of chemistry
  - do acids in one unit
  - less emphasis on knowledge, more on skills and attitudes; reduce number of topics and depth

Comments Specific to Physics 20–30 (20 responses received)

- Ninety percent of respondents indicated that the 1998 program of studies was meeting the needs of students fairly well to very well. Representative comments have been paraphrased below:
  - Grade 11 has a good balance of topic range and depth; 30-level is too narrow in scope and focused on academic exercises
  - if students persist to the 30 level, the basics are included to prepare for post-secondary studies

  - students are very formula sheet and calculator dependent, think of physics as a discipline of plugging numbers into formulas; can solve the problems but don't understand the underlying concepts
  - too little rigour in junior high does not prepare well for senior high; i.e., math skills
  - pay more attention to role of technology in the program
  - physics is becoming more popular with students
  - Physics 20–30 is fine as is
  - optimal implementation of program requires excellent facilities and equipment
  - practical applications need to become more prominent
  - integrate math into physics curriculum
  - concept of uncertainty requires more emphasis
  - students need foundational skills of formula manipulation and trigonometry to do well in physics
  - may need to give up some knowledge base to have more time for application, synthesis and problem solving
  - omit geometric optics in Physics 20, add radiometric optics to Physics 30
  - astronomy and cosmology could be better represented in the program
  - graphing skills need more emphasis
- Half of respondents found the learner outcomes to be stated clearly and in appropriate detail. Representative comments have been paraphrased below:
  - use tables so rows and columns can be followed
  - consider putting STS and attitudes first, followed by skills, with knowledge last
  - unevenness in level of detail
  - the course of studies is not a curriculum guide—this is not well understood by teachers
  - documents of the size and complexity of the math Western Canadian Protocol should not be used as a model
- About 45% indicated that the learning resources supported the program of studies fairly well or well. Twenty percent suggested a major resource change was needed. Representative comments have been paraphrased below:
  - physics text needs to be improved
  - supplementary physics materials are good
  - lacking easy-to-follow STS resources
  - physics labs tend to be outdated
  - STS connections in text quickly outdated—opportunity for Web-based resources
- When asked how extensively the program should be revised, 45% of respondents recommended minor to major changes. Representative comments have been paraphrased below:
  - make minor revisions, paying attention to recent developments in physics
  - emphasize sound in waves unit of Physics 20
  - make better use of computer learning

Highlights from the ATA Science Council Conference Senior Secondary Science Survey (November 2000)

The ATA Science Council asked all delegates attending Conference 2000 to respond to upcoming changes planned for the senior high school discipline science courses. Seventy-four questionnaires were completed; 58 were from teachers of science at the grades 10 to 12 level. The majority of respondents indicated that changes to the programs were needed. The following table summarizes their recommendations for change to the senior high school program:

Senior Secondary Science Survey
ATA Science Council Conference, November 2000

Course	Percent of Respondents Indicating Degree of Change to Course of Studies Needed			
	No Change	Minimal Change	Moderate Change	Extensive Change
Biology 20–30	17%	35%	37%	11%
Chemistry 20–30	18%	41%	36%	5%
Physics 20–30	4%	40%	48%	8%

Sample comments on general topics are paraphrased below:

- improve continuity from Science 7–8–9 and Science 10 to the discipline sciences
- specific learner outcomes could be written in more specific terms
- diploma exams tend to extend learner outcomes beyond the Course of Studies
- allow more time for exploration, scientific inquiry, reflection and skill development
- content sequencing could be improved
- address and test attitudes
- the 30-level program of studies must indicate specific learner outcomes that will be tested on the diploma exams and the topics not to be included
- need to stress the ethics of science and help students to judge information (e.g., articles on internet)
- update resource material and content to reflect advances in technology, etc.
- build in Information and Communication Technology (ICT) learner outcomes
- apply what we have learned from brain research
- expand and broaden to include careers directly and indirectly related to science
- facilitate transition from high school to university

Sample comments on Biology 20–30 are paraphrased below:

- reduce detail on cellular respiration and photosynthesis (or place in Biology 30)
- Biology 30 genetics needs to be updated in relation to technologies
- include muscles and muscle contraction (major concept missing from Biology 20–30)
- include section on cancer (very important as it will soon be the #1 killer of adults over 50)
- exclude Chaos Theory (to allow more time for the above)
- evolution including population genetics at the Biology 30 level
- insufficient treatment of plant topics
- extend organism diversity to include non-human forms
- keep ecology topic together (put populations and communities together)
- keep evolution with population genetics to be consistent with change theme in Biology 30
- with the completion of the Human Genome project, the learner outcomes need to be updated

- move some of the content from Biology 30 (e.g., meiosis/mitosis) to Biology 20
- Biology 20–30 is a great course—little need for change
- put all physiology together at Biology 20 level
- less on ecology—some is repetitive of Science 10

Sample comments on Chemistry 20–30 are paraphrased below:

- Science 10 could provide better preparation for Chemistry 20
- careful thought should go into allowing time to teach or re-teach the prerequisites needed for Chemistry 20
- give students a better understanding of the relationship between the concentration of an acid or base and ionization
- there is too much content in Chemistry 30 especially, it would be better to reduce content and therefore provide more opportunity to explore topics more fully
- add more detail to equilibrium
- increase STS content but no more can be added until some content is removed
- cut down the amount of content
- look at broader topics (e.g., organic chemistry, rates of reaction)
- put more organic chemistry at the 30 level
- in Chemistry 20 greater emphasis on organic, less on stoichiometry which is handled better by grade 12s than grade 11s

Sample comments on Physics 20–30 are paraphrased below:

- the electrical chapter (e.g., parallel and series circuits) should be developed more or taken out and made into a Career and Technology Studies (CTS) course
- physics requires more modern component—1990's research
- Physics 20 is too broad; prerequisites to Physics 30 should be emphasized
- some Physics 20 topics could be covered in Science 10 (Science 10 physics unit could better prepare students for 20 and 30 level)
- Physics 20/30 should incorporate astronomy/cosmology more explicitly
- include statistics in dynamics unit
- take out memorization of frequencies and electromagnetic radiation (EMR) varieties; knowledge of properties OK, but what point is there in pure memorization of numbers
- stronger emphasis in classical mechanics and application of conservation of energy principles; somewhat less is required for topics such as circular motion and modern physics—this is more university level
- Physics 30 program should have the material on Einstein and relativity reinstated. It seems to leave the nature of the atom unit undone, or at a point where the thinking is antiquated.

Meetings of the Advisory Committee

The Science 10–12 Advisory Committee was established to work under the direction of Alberta Learning staff in revising the senior high school science programs of study. Members were nominated by the Alberta Teachers' Association, school authorities from across the province, Alberta post-secondary institutions, and businesses and industries. The committee members provided advice to Alberta Learning on the content of the programs of study based on their experiences as classroom teachers, post-secondary educators or employees of a business or industry. The members were asked to gather feedback from colleagues in their organization to bring back to the discussion and working groups—an important aspect of the consultation process. This committee met on the following dates, but members also prepared and reviewed documents on their own time, and provided additional feedback by e-mail and telephone conference calls. Committee members carefully considered the input summarized in this report in the preparation of drafts of the program outcomes.

Meeting Dates	Objectives
November 30, 2001	Orientation to the task Vision for the senior high school science program
January 25, 2002	Review of needs assessment and study of background information
October 10–11, 2002	Writing and development
December 2–3, 2002	Writing and development
January 27–28, 2003	Preparation of discussion drafts
March 6–7, 2003	Writing and development
May 1–2, 2003	Preparation of consultation drafts
November 24–25, 2003	Review of feedback on consultation drafts Writing and development
February 23, 2004	Preparation of resource development drafts

SECTION C: Responses to Consultation Drafts for Biology 20–30, Chemistry 20–30 and Physics 20–30

Highlights from Round-table Discussions at the ATA Science Council Conference and Science Regional Meetings (2003)

The June 2003 consultation drafts of the program outcomes for Biology 20–30, Chemistry 20–30 and Physics 20–30 were distributed to working groups and at formal presentations for feedback and discussion. The following is a summary of input from these round-table discussions attended by approximately 90 individuals.

General Comments

Most general comments reinforced what was recorded in earlier surveys:

- Support was strong for incorporating as many or more examples of STS connections.
- Some respondents would like to see a story line carried through each unit of study.
- Caution was advised about adding any more content to the programs which are challenging to cover already—if something is added, something else must be taken out.
- Ensuring articulation from lower level to higher level courses was a fairly high priority for many participants.
- Revised or new learning and teaching resources were recommended for all programs.
- How to incorporate information and communication technology (ICT) into learning should be considered in the revisions.
- Alignment of provincial assessments with program outcomes was seen as important.

Sample Comments and Responses for Biology 20–30

- *Won't there be overlap between ecology outcomes in Biology 20 and similar outcomes in junior high science and Science 10?*
  Alberta Learning Response: The science program has been carefully reviewed from junior high to senior high to ensure articulation without overlap. Ecology outcomes are considered to be at the appropriate standard for each grade level. The revised Biology 20 program has a greater emphasis on quantitative aspects of food webs, and the study of biomes has been delimited as this is now addressed in Science 10.
- *Outcomes related to the principles of taxonomy appear to be an add-on and do not fit well where inserted into the program—with the field study.*
  Alberta Learning Response: Principles of taxonomy is no longer included in Grade 9 Science but is required as part of the background information for the field study in Biology 20. The field study is the most logical place to insert classification of organisms, as it is most relevant here when identifying collected specimens.
- *Why is the field study compulsory in Biology 20? Some teachers, especially those implementing the course in colleges and adult-upgrading institutions, other than regular K–12 schools, have difficulty implementing this component.*
  Alberta Learning Response: The field study is a compulsory component of the current Biology 20 program and remains thus in the revised program. It is an integral part of the program that provides all students, including adult learners, with an opportunity to experience ecological concepts first-hand.

- *The sequencing of concepts in Unit C does not appear logical. Classical genetics should precede cell division, Mendelian genetics and patterns of inheritance.*
  Alberta Learning Response: The order of topics was carefully reviewed by the committee. Cell division is a basic concept that is introduced in the junior high school science program. The program of studies does not prescribe the sequence in which concepts are to be taught. Teachers can organize and present the concepts in the order that best meets the needs of their students.
- *The changes to Biology 20–30 are minimal. I was expecting more significant revisions.*
  Alberta Learning Response: The needs assessment indicated general satisfaction with the program. Most changes were made to ensure articulation with changes made to programs at earlier grade levels and to update knowledge resulting from recent research and the STS connections.

Sample Comments and Responses for Chemistry 20–30

- *The proposed organization of acids and bases between the 20 and 30 levels is problematic: Bronsted-Lowry needs to be discussed within the context of equilibrium. The Bronsted-Lowry concept of acids and bases should not be required to complete Chemistry 20.*
  Alberta Learning Response: This has been addressed in the next draft of the proposed program. In Chemistry 20, acids, bases and neutralization are defined in terms of modified Arrhenius definitions. In Chemistry 30, Bronsted-Lowry reactions will not be required to complete equilibrium problems. Simple homogeneous chemical reactions at equilibrium will be used to calculate equilibrium constants or equilibrium concentrations.
- *Logarithms are not covered in mathematics until grade 12—students may have difficulties with pH and pOH calculations in Chemistry 20.*
  Alberta Learning Response: Classroom mathematics teachers tell us that concentration to pH conversions and pH to hydronium ion concentrations, using a calculator, can be learned by Grade 11 students, building on their ability with exponents. Currently, many students take Chemistry 30 before Pure Mathematics 30 and this does not appear to be a barrier to their completing these types of problems.
- *Concern was expressed about finding safe activities for the organic chemistry section in Chemistry 30.*
  Alberta Learning Response: Safe activities for the organic chemistry section are a very important consideration; this has not changed with the introduction of organic chemistry in Grade 12. Safe and limited laboratory activities are provided in the outcomes for the revised program, and a safety resource is near completion that will provide additional guidance. Demonstrations, video and multimedia simulations can be considered as an alternative to hands-on activities in institutions where there are restrictions or particular sensitivities.
- *Teachers will need to see what kinds of questions will be asked on the diploma examination before knowing if this is doable.*
  Alberta Learning Response: Sample preview diploma examination questions will be provided so that teachers and students can study the depth and emphasis that will be expected on future Chemistry 30 diploma examinations.

- *Has enough content been taken out of Chemistry 30 to make room for the addition of the unit on organic chemistry?*
  Alberta Learning Response: It would not be workable to add a unit to Chemistry 30 without removing the equivalent of a unit. The overall length and difficulty of the proposed new program is considered comparable to the present Chemistry 20–30 program. When organic chemistry was moved to Chemistry 30, the scope was reduced. In addition, a component of the thermochemistry unit was moved to Science 10.

Sample Comments and Responses for Physics 20–30

- *To motivate students most of the physics is best taught within a single context such as cosmology/astrophysics; on the other hand some teachers prefer to select a context, rather than having one chosen for them.*
- *Would like to leave flexibility in the curriculum for creative teachers—yet provide guidance for young and inexperienced teachers.*
  Alberta Learning Response: Providing example contexts in the program outcomes and the physics resource offers the opportunity for teachers to select the context or story line that suits their background and meets the needs of their students.
- *How much of electricity and optics is covered in junior high given that this has been limited in the physics program?*
  Alberta Learning Response: In Grade 9 Science, students analyze, qualitatively and quantitatively, simple series, parallel and combination circuits using Ohm's law; and they study the principles of DC motors and generators. Reflection and refraction are introduced in Grade 8 Science. In Grade 8, students also analyze two lense systems (microscope and telescope) using ray diagrams. Optical instruments are revisited in Grade 9 Science.
- *Could we have a companion document that provides greater guidance re depth of treatment?*
  Alberta Learning Response: Program designers have done their best to make the outcomes as clear as possible. The Diploma Examination Bulletins and Reports provide additional information.
- *Would like to see some optional topics.*
  Alberta Learning Response: The electives model for program outcomes was considered unsuccessful by most jurisdictions, as this component tended not to be implemented with a diploma examination in place.
- *Role of curriculum is to be more than a list of topics—needs to give guidance to teachers on use of contexts.*
  Alberta Learning Response: The role of the program of studies document is to identify the goals of science education and the expected learning outcomes. The basic resources selected to support the program outcomes provide additional guidance to students and teachers.
- *Move momentum into Physics 20.*
  Alberta Learning Response: Discussions with physics teachers indicated that the depth of study suggested is more successfully achieved by Grade 12 students.
- *Technology is overtaking our studies in science—too much emphasis on science and technology.*
  Alberta Learning Response: Science and technology are intrinsic to one another, particularly in physics. In addition, Alberta Learning is committed to the implementation of the information and communication technology (ICT) outcomes within all programs.

- *Add DC circuits and AC and DC motors and generators.*
  Alberta Learning Response: Changes to the junior high school science program to include more emphasis on these topics, and the direction to reduce content indicated by the 1997–1998 needs assessment, led to the decision to reduce the emphasis on these topics in the physics program.
- *Resist the urge to overdo the use of math in science—too much emphasis in the current program—demotivating—need to bring in real-life examples.*
  Alberta Learning Response: The mathematics required to successfully complete the physics program is considered to be within the knowledge and skills repertoire of Grade 11 and Grade 12 students.
- *I think we need new materials that are fresh and interesting to students—a different approach that brings in more contexts.*
  Alberta Learning Response: New resources that meet all of the learning outcomes, vision, rationale and philosophy of the program of studies will be selected.

Summary of Responses to Questionnaire on Consultation Drafts

The consultation drafts of the program outcomes for Biology 20–30, Chemistry 20–30 and Physics 20–30 and a response questionnaire were posted on the Alberta Learning Web site between June 2003 and January 2004. Thirty online responses were received, the majority from classroom teachers. The following is a summary of the data and written responses.

Section A of the Response Questionnaire – Respondent Information

Question A1: I am responding primarily as a(n).

classroom teacher grades 7–12	7%
classroom teacher grades 10–12	73%
high school student	3%
university/college faculty	10%
other	7%

The majority of respondents (80%) were classroom teachers.

Section B of the Response Questionnaire – Program Introduction

Question B1: Program Rationale and Philosophy

This is a clear description of the direction for the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	9%	9%	60%	22%

Most respondents (82%) agreed or strongly agreed that the Program Rationale and Philosophy clearly indicates the direction for the senior high school science program.

Question B2: Program Foundations

2a. Foundation 1 includes the general attitudes that students need to develop in the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	10%	14%	52%	24%

A significant percentage of respondents (76%) agreed or strongly agreed that Foundation 1 includes the general attitudes that senior high school science students need to develop.

Representative written comments from respondents are as follows:

- *Mutual Respect: might as well add, "...different views and background" to the end (as in General "Program Introductions Draft June 2003," page 3). Keep it the same as it is there!*
  Response/action related to the above input:
  Thank you—that change will be made.

2b. Foundation 2 includes the general knowledge that students need to develop in the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	0	19%	48%	33%

The majority of respondents (81%) agreed or strongly agreed that Foundation 2 includes the general knowledge that senior high school science students need to develop.

2c. Foundation 3 includes the major ideas of science, technology and society (STS) that students need to develop in the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	14%	24%	38%	24%

Most respondents (62%) agreed or strongly agreed that Foundation 3 includes the major ideas of science, technology and society (STS) that senior high school science students need to develop.

Representative written comments from respondents are as follows:

- *An understanding of the development and limitations of current scientific methodology could be included here.*
- *The descriptions that follow scientific inquiry and collaboration could be more precise—are they inclusive of curiosity and skepticism?*
- *What about the role of language, especially written texts in scientific advancements?*

- *The description emphasizes science as a way of learning without highlighting the social aspects of science such as where scientists engage in debates, get their funding and publish articles—and where they work.*
  Response/action related to the above input:
  Additional research has been initiated to determine how to best include these aspects.

2d. Foundation 4 includes the general skills that students need to develop in the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
14%	4%	18%	32%	32%

This question elicited a diverse response. Although 64% of respondents agreed or strongly agreed that Foundation 4 includes the general skills that senior high school science students need to develop, 14% strongly disagreed.

Representative written comments from respondents are as follows:

- *Being able to critically read diverse genres of scientific texts should be identified as a skill under Communication. Consider "critical reading" as a separate category.*
  Response/action related to the above input:
  This skill level is considered to be appropriate as an introductory level for Grade 11 and Grade 12 students and will be considered for inclusion.
- *Analyzing and Interpreting category could make explicit the need to study errors/unexpected outcomes as valuable components in the development/revision of theories.*
  Response/action related to the above input:
  This will be considered for inclusion.

Question B3: Frameworks for Science, Technology and Society

3a. The Nature of Science Framework contains concepts and skills that students need to develop in the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	5%	24%	38%	33%

Most respondents (71%) agreed or strongly agreed that the Nature of Science Framework contains concepts and skills that senior high school science students need to develop.

3b. The Science and Technology Framework contains concepts and skills that students need to develop in the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5%	0	25%	35%	35%

A significant percentage of respondents (70%) agreed or strongly agreed that the Science and Technology Framework includes concepts and skills that senior high school science students need to develop.

3c. The Social and Environmental Framework contains concepts and skills that students need to develop in the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	10%	14%	57%	19%

A majority of respondents (76%) agreed or strongly agreed that the Social and Environmental Framework contains concepts and skills that senior high school science students need to develop.

Question B4: Program Organization

This is a clear description of the components in the senior high school science program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
0	9%	18%	50%	23%

Most respondents (73%) agreed or strongly agreed that this section clearly describes the components of the senior high school science program.

Section C of the Response Questionnaire – Program Outcomes

Question C1: Attitude Outcomes

1a. The outcomes for attitudes clearly explain what students will be encouraged to know and do.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	14%	0	72%	14%
Chemistry 20–30	0	13%	25%	37%	25%
Physics 20–30	0	13%	13%	61%	13%

The majority of respondents indicated that they agreed or strongly agreed that the outcomes for attitudes clearly explain what students will be encouraged to know and do in Biology 20–30, Chemistry 20–30 and Physics 20–30. However, some disagreed in each discipline.

1b. The outcomes for attitudes are appropriate for students in this program.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	0	25%	75%	0
Chemistry 20–30	0	12%	25%	50%	13%
Physics 20–30	0	0	12%	75%	13%

The majority of respondents considered the attitude outcomes appropriate for senior high school science students.

Representative written comments from respondents are as follows:

Biology 20–30

- *Scientific attitudes (predisposition to act) should be included not attitudes towards science.*
  Response/action related to the above input:
  The approach taken within the attitudes component correlates with the attitudes described in the Pan-Canadian Science Framework.

Chemistry 20–30

No comments recorded

Physics 20–30

- *Interests, attitudes and student involvement are largely determined by the teacher and the resource available to the teacher and students. Interesting and good resources play a major role in student response.*
  Response/action related to the above input:
  The resource to be selected for the Physics 20–30 program will support the stated learner outcomes for attitudes, knowledge, skills and STS.

Question C2: General Outcomes

2a. The general outcomes for each unit clearly explain what students are expected to know and be able to do.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	12%	13%	63%	12%
Chemistry 20–30	0	14%	0	72%	14%
Physics 20–30	0	0	13%	75%	12%

Most of the respondents indicated that the general outcomes for each unit clearly explain what students are expected to know and be able to do in each subject.

2b. The general outcomes for each unit are appropriate for students in this program.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	12%	13%	38%	37%	0
Chemistry 20–30	0	14%	29%	43%	14%
Physics 20–30	12%	0	13%	75%	0

Respondents considered the general outcomes for each unit in Chemistry 20–30 and Physics 20–30 to be appropriate for senior high school science students. Some respondents indicated less support for the appropriateness of the general outcomes, particularly in Biology 20–30.

Representative written comments from respondents are as follows:

Biology 20–30

- *Bio 20, Unit B Outcome 2 is about evolution – call it that!*
  Response/action related to the above input:
  The concepts on evolution are included within the context of population change. The specific terminology is in the specific outcomes; e.g., B2.2k, B2.3k and B2.6k.

Chemistry 20–30

- *Explanations are too general to be of value in defining the limits of the document.*
  Response/action related to the above input:
  Outcomes have been carefully reviewed and have now been made more specific. This was done in collaboration with the Learner Assessment Branch to ensure fair questions on future diploma examinations.

Physics 20–30

- *Circuits and Ohm's Law need to be covered at the grade 12 level. Grade 9 is not enough. Physics 20—the energy unit should stay in Physics 30, as the 20's will not be able to handle this material. Although, the light unit does fit with Unit 4 Atomic Theory in Physics 30, why not leave it in Physics 20?*
  Response/action related to the above input:
  The needs assessment of 1997–1998 indicated to the curriculum committee that content reduction and the inclusion of 20th century physics topics should be the focus of any Physics 20–30 revisions. Changes to the junior high science curriculum provide an opportunity to drop the more concrete concepts in optics and electricity and retain the more abstract ideas by rearranging topics.

- *I feel that our curriculum committees are trying to implement point 1 (less is more) and 3 (include 20th century physics), but there is considerable resistance to point 2 (use a story line)...*
  Response/action related to the above input:
  The curriculum committee was advised by teachers to suggest possible contexts and leave the decision to individual teachers about which story line to follow.

Question C3: Outcomes for Knowledge

3a. The specific outcomes for knowledge in each unit clearly explain what students will be expected to know.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	0	29%	71%	0
Chemistry 20–30	0	12%	13%	63%	12%
Physics 20–30	0	12%	13%	63%	12%

Most respondents indicated agreement that the specific outcomes for knowledge clearly explain what students in Biology 20–30, Chemistry 20–30 and Physics 20–30 will be expected to know.

3b. The specific outcomes for knowledge in each unit are appropriate for students in this program.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	14%	29%	0	57%	0
Chemistry 20–30	12%	25%	13%	38%	12%
Physics 20–30	0	28%	29%	43%	0

Although, a majority of respondents indicated they consider the specific outcomes for knowledge appropriate for students in Biology 20–30 and Chemistry 20–30, a significant percentage also registered disagreement. Physics 20–30 respondents appear to be uncertain, with a significant number indicating neutrality or disagreement.

Representative written comments from respondents are as follows:

Biology 20–30

- *Surprised to see binomial nomenclature added to Bio 20.*
  Response/action related to the above input:
  This topic is no longer covered in junior high science and is needed for classifying organisms in field studies.

- *Park examples could be used: road impact on animals, introduction of species of fish, reclamation.*
  Response/action related to the above input:
  Some such examples have been incorporated.

- *Do cyanobacteria have to be mentioned in Unit 1, Outcome 3.3k relating to changes in atmospheric composition over the history of the Earth?*
  Response/action related to the above input:
  The outcome is broad enough that cyanobacteria will be discussed.

- *General Outcomes in Bio 20, Unit 2, could include the requirement to differentiate between evolution and natural selection.*
  Response/action related to the above input:
  The distinction between the two naturally occurs in the course of developing the concept of evolution.

- *Glad to see the Chaos Theory removed.*

Chemistry 20–30

- *What is the logic in switching this (acids and bases) with organic chem? Both are covered in the program already, and at more appropriate levels.*
  Response/action related to the above input:
  Many respondents and members of the advisory committee felt strongly that organic chemistry, particularly in Alberta's petrochemical industries, deserved a higher priority. To place organic chemistry in Chemistry 30, some components of acid-base were moved to Chemistry 20 to round out the introduction that was already included there.

- *I feel that moving pH and pOH calculations to grade 11 is an error. We are asking students to use abstract concepts before they are ready for them. Keep logarithms in grade 12.*
  Response/action related to the above input:
  Mathematics teachers and curriculum designers advise that pH/pOH calculations can be ably handled by Grade 11 students.

- *Students are still expected to understand acid-base equilibria and buffer systems. These cannot be taught without a knowledge of weak acids and bases.*
  Response/action related to the above input:
  The program has been adjusted with strong and weak acids and bases introduced in Chemistry 20, providing the background for equilibria and buffers in Chemistry 30.

Physics 20–30

- *Circuits and Ohm's Law need to be covered at the grade 12 level.*
  Response/action related to the above input:
  The needs assessment of 1997–1998 indicated to the curriculum committee that content reduction and the inclusion of 20th century physics topics should be the focus of any Physics 20–30 revisions. Changes to the junior high science curriculum provide an opportunity to drop the more concrete concepts in electricity and retain the more abstract ideas by rearranging topics.

- *This is a small change. Physics 20 will be more concrete than before and Physics 30 less so. Both courses will have lots of opportunity for lab/project work.*
  Response/action related to the above input:
  The 1997–1998 needs assessment indicated that only minor revisions to the current courses are necessary.

- *AC and DC motors, DC circuits ... should be included.*
  Response/action related to the above input:
  Outcomes related to these topics are included in the revised Grade 9 Science.

- *I strongly suggest that you put anything that should be core material (and tested on the diplomas, etc.) into the Knowledge section.*
  Response/action related to the above input:
  All knowledge, STS and skill outcomes that are testable in a written examination format are assessed on the diploma examination. The italicized examples are provided in the program of studies as suggestions for instruction and for resource development.

Question C4: Outcomes for Science, Technology and Society

4a. The outcomes for science, technology and society in each unit clearly explain what students will be expected to know and be able to do.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	0	37%	63%	0
Chemistry 20–30	0	14%	43%	29%	14%
Physics 20–30	14%	15%	14%	57%	0

Most Biology 20–30 respondents (63%) agreed that the science, technology and society outcomes clearly explain what students will be expected to know and be able to do. An equal number of Chemistry 20–30 respondents (43%) indicated a neutral position or agreement to this question. Although the majority (57%) of the Physics 20–30 respondents indicated that they agree that the outcomes for science, technology and society clearly explain expectations, a significant number disagreed or strongly disagreed.

4b. The outcomes for science, technology and society in each unit are appropriate for students in this program.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	12%	25%	63%	0
Chemistry 20–30	0	14%	29%	43%	14%
Physics 20–30	0	29%	14%	57%	0

The majority of the respondents agreed that the outcomes for science, technology and society in each unit are appropriate for senior high school science students. However, 29% of the Physics 20–30 respondents indicated disagreement.

Representative written comments from respondents are as follows:

Biology 20–30

- *Can labs on growing bacteria/plants in Bio 20 be virtual labs instead? Are on-line simulations being developed?*
  Response/action related to the above input:
  Implementation of the program needs to suit the context of the classroom—yes, virtual labs can be used. Alberta Learning and publishers/developers will be developing some support multimedia components, which may include simulations.

Chemistry 20–30
No comments recorded

Physics 20–30

- *I assume that the examples listed under STS outcomes are suggestions and not mandated items. You should seriously consider making some of these mandatory.*
  Response/action related to the above input:
  The majority of teachers indicated to the committee that the specific STS context should be their choice. The general outcomes for STS are mandatory.

Question C5: Skill Outcomes

5a. The outcomes for skills in each unit clearly explain what students are expected to be able to do.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	12%	25%	63%	0
Chemistry 20–30	0	14%	29%	43%	14%
Physics 20–30	0	0	0	78%	22%

The majority of Biology 20–30 and Chemistry 20–30 respondents agreed that the outcomes for skills clearly explain what students are expected to be able to do in each unit. For Physics 20–30 all respondents indicated agreement to this question.

5b. The outcomes for skills in each unit are appropriate for students in this program.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	12%	13%	25%	50%	0
Chemistry 20–30	0	14%	29%	43%	14%
Physics 20–30	0	22%	11%	56%	11%

Biology and physics respondents indicated less agreement with the appropriateness of the outcomes for skills than they did in question 5a. Chemistry 20–30 respondents indicated the same level of agreement as in question 5a.

Representative written comments from respondents are as follows:

Biology 20–30

- *Too many skill outcomes.*
  Response/action related to the above input:
  Not all of the skill outcomes are required. Adequate choices are provided to suit various learning situations.

Chemistry 20–30

- *I hope that the skills will continue to be tested on the diploma examinations. I put a large emphasis on laboratory activities, and it's nice to see that Student Evaluation does too.*
  Response/action related to the above input:
  Skill development is one of the major foundations of the program of studies. Laboratory skills will continue to be evaluated.

- *Outcomes are appropriate; however, technology in most schools is not adequate.*
  Response/action related to the above input:
  Alberta Learning supports the implementation of the Information and Communication Technology (ICT) curriculum within all program areas. In addition to funding assistance for the purchase of hardware and software, multimedia learning resources have been made available through the LearnAlberta.ca Web site.

Physics 20–30

- *Under kinematics need to add graphical analyses of motion.*
  Response/action related to the above input:
  Graphical analysis is included in the skill outcomes of Units A, B and C of Physics 20.

- *There are some good ideas but the equipment required for a majority of the suggestions is lacked in our lab.*
  Response/action related to the above input:
  The committee took great pains not to mandate any laboratory activities requiring highly sophisticated equipment. The resource will provide examples of how to attain the skill outcomes indicated, and computer simulations are an option.

Question C6: The examples (*italicized sections*) provide appropriate contexts and connections for general and specific outcomes.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	12%	25%	63%	0
Chemistry 20–30	0	25%	13%	50%	12%
Physics 20–30	11%	0	33%	45%	11%

Most of the respondents, in each subject, agreed that the examples provide appropriate contexts and connections for general and specific outcomes. However, a significant percentage registered disagreement in each discipline.

Representative written comments from respondents are as follows:

Biology 20–30

- *These STS examples are often difficult to interpret. For example, 20-A3.1sts – what is the relationship between societal needs and capabilities and how well a terrarium functions?*
  Response/action related to the above input:
  Wording of the STS outcomes has been reviewed and improved to reduce ambiguity.

Chemistry 20–30

- *Most are too vague. Examples relating to testable criteria would be nice.*
  Response/action related to the above input:
  The examples are provided as suggestions for instruction and for resource development. Specific details will not be tested on the diploma examination but may be used as contexts for questions.

- *I would be unable to do most of the suggested activities due to a lack of computers.*
  Response/action related to the above input:
  Most of the activities suggested will not require sophisticated computer technology, and alternatives will be provided in the learning and teaching resources.

Physics 20–30

- *In most cases the examples are good.*

- *The success or failure of this section will have a large part based on what can be found. There is opportunity to put a thematic emphasis (sports, cars, space, music) if a teacher wants to but a thematic approach isn't mandatory (a good thing).*

- *Very sparse in Physics 30.*
  Response/action related to the above input:
  The examples are provided as ideas. Teachers are encouraged to select examples that meet their specific needs. Additional examples will also be included in the resource selected for Physics 20–30.

Question C7: The organization of the program is logical and sequential.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	11%	22%	56%	11%
Chemistry 20–30	12%	38%	12%	25%	13%
Physics 20–30	11%	11%	23%	44%	11%

A significant percentage of Biology 20–30 respondents (67%) agreed or strongly agreed that the organization of the program is logical and sequential. Fifty percent of the Chemistry 20–30 respondents disagreed or strongly disagreed that the program organization is logical and sequential. Over half of the Physics 20–30 respondents indicated agreement that the program organization is logical and sequential.

Representative written comments from respondents are as follows:

Biology 20–30

- *Move "Population Dynamics" out of Biology 30 and put it in Biology 20. The mathematics of population change should be taught with evolution.*
  Response/action related to the above input:
  The correlation between the concepts in Biology 20 and Biology 30 was carefully considered in the review. It was decided that placing all of the topics related to species and population changes into one level would result in too little variety within one or the other of the courses. Evolution does have a good fit with ecosystems and also has strong connections to population dynamics. By placing some of the topics at each level, student interest is better maintained, and those students who do not go on to Biology 30 have experienced a broader view of biology.

- *Order of content in Bio 30 should have mitosis and meiosis precede reproduction.*
  Response/action related to the above input:
  The order of the knowledge outcomes in the program of studies does not prescribe the order in which concepts shall be taught. Teachers can cover concepts in the order that best suits their teaching style and the needs of their students.

- *Symbiotic relationships fit better into Bio 20.*
  Response/action related to the above input:
  Symbiotic relationships could have fit into either place. They were placed in the population dynamics unit to provide for a better balance of time required for each level.

Chemistry 20–30

- *Chemistry 20 has stoich near the end. I would start with stoich and carry that theme through the course.*
  Response/action related to the above input:
  Integrating material across units is an excellent presentation methodology. The committee reasoned that many concepts needed to be explored before they are applied in stoichiometric calculations. The order of the units in the program of studies is not prescribed. Teachers may present the material in the order that best suits their teaching style and the needs of their students.

- *I think that the acid base calculations and titration curves are way too advanced for chem 20's. As well, why talk about acid/bases before equilibria?*
  Response/action related to the above input:
  Acid-base calculations and titration curves are limited to strong acid-strong base situations in Chemistry 20. Students define acids and bases in limited ways (Arrhenius modified) at the 20 level. Equilibrium concepts are related to Bronsted-Lowry acids/bases in Chemistry 30.

Physics 20–30

- *Relativity is needed for Einstein's mass-energy and for the kinetic energy of the electron in the Compton effect in P30.*
  Response/action related to the above input:
  Relativity is not essential for either of these ideas to be presented at the intended level of this curriculum.

- *The section on waves does not really fit into the conservation of energy. Transfer of energy and reflection on a high school level of understanding do not have a great deal in common, at least on the level it is taught.*
  Response/action related to the above input:
  Introducing waves at this level allowed the topic to be limited to mechanical waves.

- *Refraction and total internal reflection should be included in mechanical waves in P20.*

- *It is true that wave properties are a property of EMR, but it looks like a fill-in.*
  Response/action related to the above input:
  The introduction of optics in the junior high science program allowed for some content reduction and for the retention of only the more abstract, quantitative treatment of wave properties in Physics 20–30.

- *Momentum is a weak fit in Physics 30, better in Dynamics of Physics 20. Conservation of Energy is an essential conceptual framework for entire Physics 30 course.*
  Response/action related to the above input:
  Discussions with teachers indicated that the suggested treatment of momentum is handled more successfully by Grade 12 students.

Question C8: The identified links to Mathematics, Information and Communication Technology (ICT) and the STS frameworks are helpful.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	12%	0	50%	25%	13%
Chemistry 20–30	0	17%	0	67%	16%
Physics 20–30	0	11%	22%	56%	11%

Most respondents, for each subject, agree that the links to mathematics, information and communication technology and the STS frameworks are helpful.

Representative written comments from respondents are as follows:

Biology 20–30

- *Will require a close look at the links to determine when they may be covered in the math curriculum.*
  Response/action related to the above input:
  The "identified mathematical links" are meant to assist the teacher (and students) to know what math skills are related to the content for the unit.

Chemistry 20–30

- *They may be helpful later, right now they make the document hard to read.*
  Response/action related to the above input:
  The links are provided to assist developers and publishers of resources as well as teachers. They will be integrated into the student and teacher materials to facilitate making connections.

Physics 20–30

- *Well done.*

- *If math objectives are given the actual objective only needs to be present.*
  Response/action related to the above input:
  The mathematics links have been provided to meet the request for a clear indication of where mathematics skills and knowledge are applied in physics.

- *Too many generalizations.*
  Response/action related to the above input:
  The purpose of the links is to indicate where the detail can be found.

Question C9: The format of the document displays the information in a clear and easy to follow manner.

Subject	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Biology 20–30	0	25%	12%	50%	13%
Chemistry 20–30	0	12%	25%	25%	38%
Physics 20–30	0	11%	11%	67%	11%

Seventy-eight percent of the Physics 20–30 respondents agreed or strongly agreed that the document format displays information in a clear and easy to follow manner. Sixty-three percent of the Biology 20–30 and Chemistry 20–30 respondents agreed that the document format is clear and easy to follow. However 25% of the Biology 20–30 respondents disagreed.

Representative written comments from respondents are as follows:

Biology 20–30

- *Program of studies is a good, well-organized document.*

Chemistry 20–30

- *What material is fair game for the provincial exam, what is enrichment and what is explored at the teacher's or student's choice?*
  Response/action related to the above input:
  The learner outcomes preceded by "students will" are the required components of the program. Suggestions for exploring these outcomes are included as examples and are written in italics. Enrichment topics are not included and are at the discretion of the teacher, related to the needs of students in the classroom.

Physics 20–30

- *Would like to see it placed in a similar manner as to the current display (landscape).*
  Response/action related to the above input:
  This display was selected after much deliberation as it collates all of the knowledge, STS and skills outcomes for each general outcome on two pages.

Question C10: The amount of material to be covered in this program is:

Subject	too little	just right	too much
Biology 20–30	14%	14%	72%
Chemistry 20–30	12%	63%	25%
Physics 20–30	22%	34%	44%

The majority of the Chemistry 20–30 respondents considered the amount of material to be appropriate. The majority of the Biology 20–30 respondents considered that the program contains too much material. The Physics 20–30 respondents provided diverse responses to this question.

Representative written comments from respondents are as follows:

Biology 20–30

- *Too much content, not enough time for exploration and labs.*
  Response/action related to the above input:
  Great care was taken to only add in the equivalent of what was removed. A final review process based on feedback from field test teachers will help to determine if the amount of content is appropriate.

- *Ecology is very redundant—many of the concepts in 20 are found in Science 9 as well.*
  Response/action related to the above input:
  This was considered in the revisions; specific decisions were made to minimize the overlap and build on those concepts taught in junior high science and Science 10.

- *Why has "muscles" been brought back?*
  Response/action related to the above input:
  This topic has been restricted to muscle contraction. Placed within the context of the other body systems this was estimated to take little additional time to cover. Adding this better aligns Biology 20 with the Pan-Canadian Science Framework recommendations.

- *Water properties are covered in Science 10—coverage in Bio 20 is redundant.*
  Response/action related to the above input:
  There will be little overlap. Emphasis at the Biology 20 level is on how these properties contribute to the role water plays in various biogeochemical cycles.

- *Program 10 days too long and takes away from lab time.*
  Response/action related to the above input:
  Skill development, including laboratory skills, is an important focus of the program. A final review process based on feedback from field test teachers will help to determine if the amount of content is appropriate.

Chemistry 20–30

- *This really depends on the level of testing at the diploma level. I have seen an approximate 20% increase in material covered over the last 13 years, and there is little time for enrichment already.*
  Response/action related to the above input:
  The revision of the program included collaboration with the Learner Assessment Branch to ensure that the outcomes are clearly written and not subject to interpretation and the addition of content.

- *Please reduce the proposed curriculum to provide additional time for laboratory work, STSE contexts and content.*
  Response/action related to the above input:
  The proposed program was developed with the advice of practising teachers who estimated the time each unit of study would require based on their classroom experience. The overall length and difficulty of the proposed program is considered comparable to the present Chemistry 20–30 program. When organic chemistry was moved to Chemistry 30, a component was deleted and part of the acids/bases unit was moved to Chemistry 20; in addition, a component of the thermochemistry unit was moved to Science 10.

Physics 20–30

- *Add circuits and Ohm's Law.*
  Response/action related to the above input:
  Changes to the junior high science program allowed these topics to be dropped to reduce the content of physics.

- *Physics 20 is heavy but doable. Physics 30 looks OK, but I think we might need some work with an electric current.*
  Response/action related to the above input:
  Electric potential difference and current are presented in P30B.2.

- *Possibly 10-20% too much – math and labs are very good, but with the amount of labs that have been added and the level of difficulty, it will make an average Physics 20/30 student not pass and you will lose quite a few in the 50-65% range.*
  Response/action related to the above input:
  In comparison to the current physics courses there is no increase in the amount of laboratory activity.

- *Kinematics unit requires more time than 13% suggested. The current Physics 20 allots 40% to this...*
  We also need to define position before defining displacement. ...they (students) need to learn to use slopes and areas on d-t, v-t and a-t graphs.
  Response/action related to the above input:
  The 40% suggested in the current program is for both Kinematics and Dynamics in Unit A. The proposed Physics 20 devotes a unit to each, for a combined 38% of the time. The proposed course takes into consideration the changes made to Science 10 in the topics of kinematics and graphical analysis.